Transportation Research Interdisciplinary Perspectives 7 (2020) 100217

Contents lists available at ScienceDirect

Transportation Research Interdisciplinary Perspectives

journal homepage: https://www.journals.elsevier.com/transportation-research-interdisciplinary-perspectives

Estimating the impacts of lockdown on Covid-19 cases in Nigeria

Kazeem Bello Ajide [a,*], Ridwan Lanre Ibrahim [a], Olorunfemi Yasiru Alimi [a,b]

[a] University of Lagos, Lagos State, Nigeria
[b] Lead City University, Ibadan, Oyo State, Nigeria

ARTICLE INFO

Article history:
Received 18 June 2020
Received in revised form 30 August 2020
Accepted 31 August 2020
Available online 6 September 2020

Keywords:
Lockdown
COVID-19
Negative binomial regression
Nigeria

ABSTRACT

The study examines the extent to which lockdown measures impact on COVID-19 confirmed cases in Nigeria. Six indicators of lockdown entailing retail and recreation, grocery and pharmacy, parks, transit stations, workplaces, and residential, are considered. The empirical evidence is anchored on the negative binomial regression estimator, due to the count nature of the dataset on the daily cases of the virus. The study established the key following findings: First, retail and recreation, grocery and pharmacy, parks, transit stations, and workplaces are statistically significant and negatively signed as relevant predictors of the virus. Second, the impact of residential is positive and statistically significant at the conventional level. Lastly, the results are robust to an alternative estimator of Poisson Regression. The emanated policy message centres on the need to direct efforts toward ensuring total compliance to the lockdown rules as it holds the key to keeping the virus under check.

1. Introduction

The present millennium has witnessed a series of health challenges ranging from the Middle East Respiratory Syndrome (MERS), first discovered in Saudi Arabia in 2012, the Western African Ebola virus in Guinea between 2013 and 2016, to the Brazilian Zika virus in 2015. Unexpectedly, the beginning of the year 2020 saw the emergence of yet another deadly virus (COVID-19), which is a severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (WHO, 2020). The first index case of COVID-19 surfaced as unknown acute pneumonia in Wuhan hospital, a city in Eastern China. Consequently, WHO declared the virus a global pandemic on March 11, 2020, WHO (Cai et al., 2020; Wang et al., 2020) having been previously recognized as a “Public Health Emergency of International Concern (PHEIC)” on January 30, 2020.

The sudden emergence of the novel coronavirus has affected the entire world in an unprecedented manner. Thus, the issue has and continues to gather momentum by day owing largely to the growing rate of human-to-human transmission, causing severe respiratory disorder, and more damaging, is its unrestrained lethality. In fact, within the space of 6 months,[1] over 7 million people have contacted the virus, causing the death of nearly 434,796 people, while about 4,272,909 recovered from the virus (Worldometer, 2020). The lack of available clinical vaccines to combating the virus prompted the global resolve for the adoption of lockdown measures, which was first implemented by the central government of China in Wuhan on January 23, 2020. This lockdown move was commended globally and particularly by the World Health Organization (WHO), tagging it as “unprecedented in public health history” (Crossley, 2020). Subsequently, there were widespread declarations of lockdown in over 100 countries between April and June 2020. This lockdown move became an inevitable option owing to both the anticipated and unanticipated macroeconomic shocks that could be triggered by the evolving virus.

Conceptually speaking, lockdown has been referred to as an emergency response imposed by the government, mandating people to stay indoors in the event of an outbreak. In the case of COVID-19, the ultimate goal of a lockdown measure is to flatten the curve of the novel virus. The exercise entails the closure of all activities-based centres such as schools, hotels, clubs, and religious houses that could make a sizable number of people come together. This apart, directives such as social distancing, banning of congregation of more 20 people, and compulsory usage of the face masks, particularly, in public places were all forcefully enforced (NCDC, 2020; CDC, 2020; WHO, 2020).

However, on the heels of the persistent increase and spread of the COVID-19 virus in the Nigerian case, the federal government eventually announced a nationwide lockdown on March 30, 2020, taking immediate effect in three states of the federation: Lagos, Ogun, and Abuja. This lockdown exercise could not, however, be sustained in the face of growing agitations of the people occasioned by the excruciating socio-economic consequences of the exercise, thus prompting the easing of the lockdown in

* Corresponding author.
E-mail addresses: kazeemajide@gmail.com, kajide@unilag.edu.ng, (K.B. Ajide), lanrid23@gmail.com, (R.L. Ibrahim), haleemphemy480@gmail.com, alimi.olorunfemi@lcu.edu.ng. (O.Y. Alimi).

[1] , Specifically, these periods ranging from January to June 2020

http://dx.doi.org/10.1016/j.trip.2020.100217

these states on May 4, 2020. This singular decision has consequently led to the rising cases of the virus across the states. According to official data, the reported daily case of the first day of easing-May 4, 2020, saw the pandemic rising to 245, the highest since the first index case was reported for the country (NCDC situation report, 2020). While the health pundits and other stakeholders alike supposedly linked the escalation of the newly reported cases of COVID-19 to easing up of the lockdown, on the one hand, there has been no systematic research attempt directed at validating or refuting this unverified claim for the country on the other hand. This study fills this void.

Against the foregoing backdrop, this study seeks to examine the impact of lockdown on COVID-19 cases in Nigeria. The present study, to the best of knowledge is the first empirical attempt at examining the effects of lockdown on COVID-19 for the country, specifically from an econometric perspective. There is no denying the fact that there have been a series of policy papers, opinions, and predictions about the pandemic for the country. However, most of these submissions can be best described as purely qualitative empirical exercise, building merely on hunches, perceptions or at best, intuitive logics. Thus, this study is quantitative based in nature, thus presenting the contribution to the stock of extant literature on COVID-19 at least from the country-specific stance. While the introductory takes up the first section, the stylized facts about the lockdown measures vis-à-vis the virus spread in Nigeria are presented in Section 2. Section 3 presents a brief review of the extant literature; Sections 4 and 5 dwell on the empirical strategy and estimation of the lockdown-COVID-19 nexus. Section 6 concludes with some policy implications and caveats.

2. Stylized facts about lockdown measures vis-a-vis COVID-19 cases in Nigeria

This segment presents the stylized facts about coronavirus cases in Nigeria during the lockdown periods. For ease of comprehension, the lockdown period is partitioned into three phases: pre-lockdown, lockdown, and lockdown easing. This division will provide a deep understanding regarding COVID-19 cases during these identified phases (see Fig. 1).

In the **pre-lockdown** phase, no palpable pattern can be discerned from the trend regarding the number of confirmed cases. The **lockdown** phase witnesses some dramatic changes in COVID-19 cases as compared to the pre-lock down period. However, in the latter part of the lockdown, there were several sporadic spikes with the highest reported cases being 238 in a single day. The **easing period** equally experiences some increases, as can be observed from the diagram. On the first day of the easing, 245 cases were recorded, while the subsequent days witness upward trends in the number of confirmed cases. Fig. 2 presents the summarized version for the three periods in which the total aggregate of the easing surpasses 13,000 altogether. The same Fig. 2 displays the state ranking with respect to the reported cases of COVID-19 in which the Lagos State surpasses other states, thus topping the list, and directly followed by FCT, Kano in that order.

3. A concise literature review

The literature on COVID-19 can, at best, be described as emerging or in its embryonic stage. Thus far, the available studies on COVID-19 have only examined the prevalence and control measures (Ceylan, 2020; Zhao et al., 2020), governance, technology, and citizen behavior (Shaw et al., 2020), socio-economic impacts (Tang et al., 2020). Other strands had equally focused on respiratory syndrome (Al-Raddadi et al., 2020), temperature (Briz-Redón and Serrano-Aroca, 2020), mortality rates (Ferdinand and Nasser, 2020; Wang et al., 2020), and climate factor (Tosepu et al., 2020), among others.

On the Nigerian front, studies have concentrated on the resurgence of Lassa fever amidst COVID-19 outbreak (Reuben et al., 2020), Almajiris displacement (Akintunde et al., 2020), comparative analysis of models and estimators (Ayinde et al., 2020), hunger prevalence (Kalu, 2020), online forecasting (Abdulmajeed et al., 2020), impact on transportation (Mogaji, 2020), and economic crisis (Ozili, 2020).

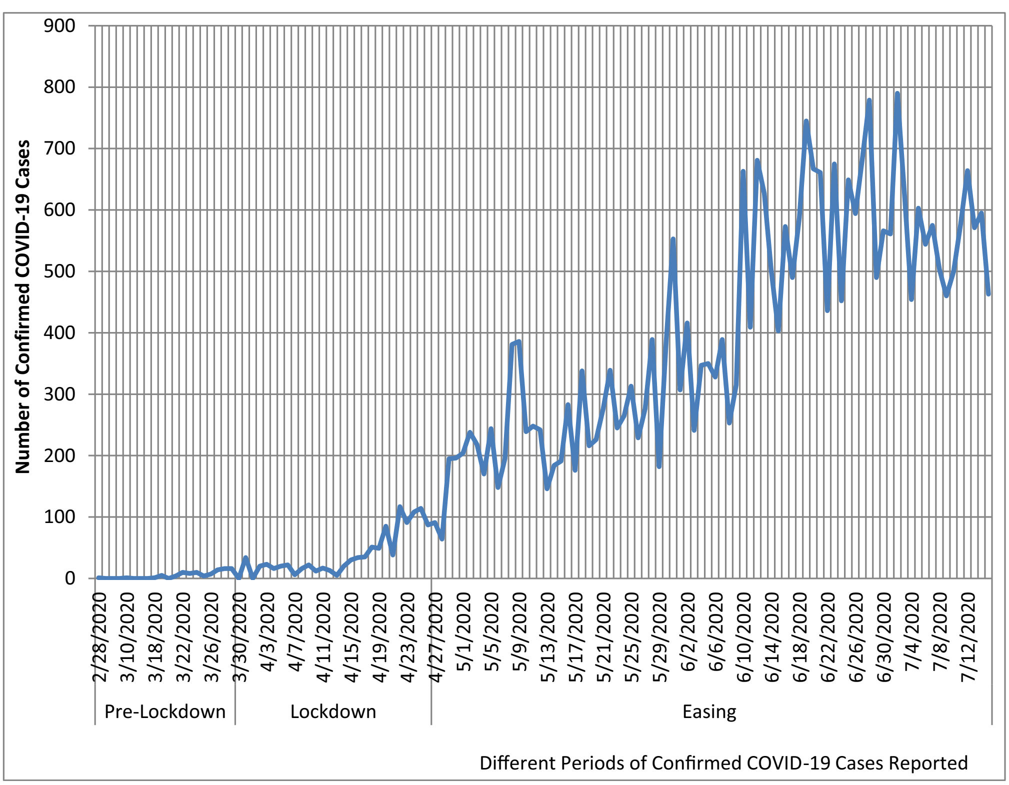

Fig. 1. Number of COVID-19 confirmed cases in Nigeria.
Source: NCDC (2020).

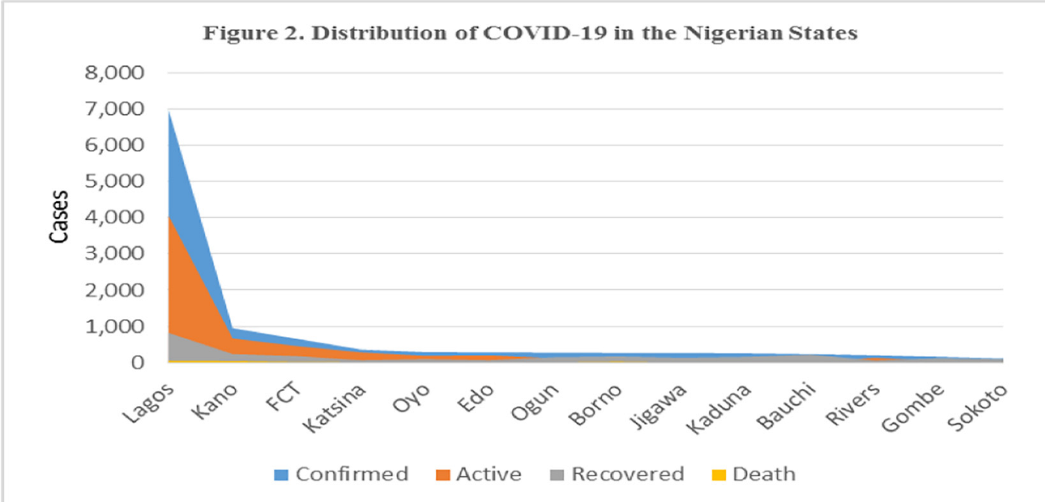

Fig. 2. Distribution of COVID-19 cases in Nigeria states. Note: confirmed = total number of confirmed positive cases of COVID-19 based on clinical tests from the index to the most recent reported cases. Active = the number of cases on admission and undergoing treatment at the various isolation centres. Recovered = the number of COVID-19 patients who have tested negatives after treatment and are certified free of the virus by medical personnel. Death = the number of people who lost their lives courtesy of the virus.

Relatedly, studies on social distancing and the spread of COVID-19 cases include De Vos (2020), Freedman et al. (2020), Schueller et al., (2020), Musinguzi and Asamoah, (2020), Vinceti et al. (2020), and Zhang et al. (2020). These studies only focused on countries from the developed and emerging nations, implying that little or nothing is on record concerning the African countries. This is in fact, surprising given the prevalent rate of the virus across the countries in the continent in general, and Sub-Saharan African economies like Nigeria in particular. This study fills this lacuna. It is worth mentioning also that the large chunk of the extant studies has only adopted descriptive or at best, discussion methods (Akintunde et al., 2020; Al-Raddadi et al., 2019; Crossley, 2020; Mogaji, 2020; Ozili, 2020; Shaw et al., 2020), while those embracing econometric approaches are scanty to date (Ayinde et al., 2020; Ceylan, 2020).

4. Methodology and data

This study employs a negative binomial regression to unravel the impact of lockdown on COVID-19 cases in Nigeria for at least two reasons; first, the dependent variable used is a count data that only covers discrete and nonnegative values. Thus, as a skewed discrete distribution, using ordinary least squares (OLS) estimates can only yield inefficient, inconsistent, and biased (Long, 1997). Second, if this dependent variable fits equidispersion, then the Poisson regression model becomes inevitable. If otherwise, using negative binomial model remains a credible option. This estimator is often used when the variance is larger than its mean (over-dispersion). The robust standard errors are further clustered in order to produce standard errors that are robust to both heteroskedasticity and a general-type of serial correlation within the cross-sectional unit. More importantly, this estimator has found extensive application in studies such as accidents, conflicts, terrorism among others, given the count data nature of their data (Gassebner and Luechinger, 2011; Krieger and Meierrieks, 2011, Ajide and Raheem, 2020; Ajide et al., 2020).

In a more general form, to specify a negative binomial regression, the mean of the outcome variable y is determined by the exposure time t and a set of k explanatory variables (the $x\,'\,s$). Hence, the empirical expression relating to these quantities is specified as:

$$\phi_i = \exp(\ln(t_i) + A_1 x_{1i} + A_2 x_{2i} + \ldots\ldots + A_k x_{ki}) \tag{1}$$

Often, $x_1 \equiv 1$ and A_1 is the intercept. The symbols $A_1, A_2, \ldots\ldots, A_k$ correspond to unknown parameters to be estimated. The empirical estimates are represented as $a_1, a_2, \ldots\ldots, a_k$. The fundamental negative binomial regression model for an observation i is written as:

$$\Pr(Y = y_i|\phi_i, \delta) = \frac{\psi(y_i + \delta^{-1})}{\psi(\delta^{-1})\psi(y_i + 1)}\left(\frac{1}{1+\delta_i\phi_i}\right)^{\delta^{-1}}\left(\frac{\delta_i\phi_i}{1+\delta_i\phi_i}\right)^{y_i} \tag{2}$$

The regression coefficients are thus estimated using the method of maximum likelihood. (see, NCSS, 2017).

4.1. Data

The study employs an all-inclusive daily situation report of COVID-19 data from relevant sources such as the WHO website (https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/), Worldometer (https://www.worldometers.info/coronavirus/), Google mobility data (https://www.google.com/covid19/mobility/), and Nigeria Centre for Disease Control (NCDC) Situation report (https://covid19.ncdc.gov.ng/). Specifically, the data on COVID-19 cases are sourced from the daily report from NCDC for each of the states over the coverage periods (Situation report 001 (February 29th covering 27th) to 88 (reporting May 26th cases). The data on lockdown is obtained from Google mobility data.

4.2. Strategic modeling and estimation technique

Following the extant literature, the baseline model for estimating the impact of lockdown on COVID-19 is stated as follows:

$$CovCases_{it} = f(Lockdown_{it}) \tag{3}$$

Eq. (3) is explicitly re-written in an estimable form as:

$$CovCases_{it} = \sigma_o + \varphi Lockdown_{it} + \varepsilon \tag{4}$$

Where; $CovCases_{it}$ denotes the total confirmed COVID-19 cases in state i at time t, *lockdown* is a vector of explanatory variables comprising retail and recreation, grocery and pharmacy, parks, transit stations, and workplaces and residential in various states at time t period; σ stands for the parameter estimates, and ε is the error term with mean zero and constant variance.

Table 1
Summary statistics.

Variables	Measurements	Grouping	Mean	Std. Dev.	Min.	Max.	Obs.
Cases	Number of reported COVID-19 cases	Overall	3.215	14.022	0	439	$N = 2414$
		Between		9.1163	0.0704	53.239	$n = 34$
		Within		10.766	−50.024	148.98	$T = 71$
rrpc	Retail and recreation percent change from baseline	Overall	−30.122	23.930	−74	62	$N = 1347$
		Between		20.716	−52.853	45.7	n = 34
		Within		16.604	−74.089	24.731	$T = 39.62$
gppc	Grocery and pharmacy percent change from baseline	Overall	−24.680	21.175	−72	33	$N = 1380$
		Between		13.008	−52.15	8.8	$n = 31$
		Within		18.612	−78.336	32.434	$T = 44.52$
ppc	Parks percent change from baseline	Overall	−24.321	19.015	−82	33	$N = 1236$
		Between		13.829	−57.475	−0.5	$n = 25$
		Within		12.509	−53.239	41.679	$T = 49.44$
tspc	Transit stations percent change from baseline	Overall	−37.908	21.499	−81	60	$N = 1121$
		Between		14.678	−74.208	−19.361	$n = 21$
		Within		17.828	−77.170	51.944	$T = 53.38$
wpc	Workplaces percent change from baseline	Overall	−20.322	19.004	−75	20	$N = 2044$
		Between		9.946	−43.607	1.7213	n = 34
		Within		16.247	−60.765	27.285	$T = 60.12$
rpc	Residential percent change from baseline	Overall	14.752	9.884	−4	45	$N = 1138$
		Between		6.182	−0.3	29.197	$n = 23$
		Within		8.570	−14.445	41.7358	$T = 49.48$

Note: COVID – coronavirus; Max. - maximum; Min. - minimum; Std Dev. - standard deviation.; Obs. - observation.

4.3. Preliminary results

The descriptive statistics are presented in Table 1. From the Table, it is clear that the number of reported COVID-19 cases averaged 3.2 with the maximum being 439. The negative values for all the lockdown indicators except residential, imply that they are inhibiting predictors. At the level of the states, Lagos has the highest recorded COVID cases (see Table 2), which is consistent with Fig. 2 above. The correlation coeficients of the variables are presented in Table 3.

5. Empirical analysis

5.1. Analysis of empirical results

Table 4 presents the results of the negative binomial regression estimations of the lockdown effects on Covid-19 for Nigeria. The results for all the indicators of lockdown variables are statistically significant and negative except for the residential variable. These results consistent with the theoretical *priors,* suggesting the mitigating role of lockdown policies on

Table 2
Numbers and average daily cases of COVID-19 from Feb 27th to May 26th, 2020.

S/N	States	Feb. 27th – Mar 30th 2020	April 1st – April 30th 2020	May 01st – May 26th 2020	Feb. 27th – May 26th 2020
1	Lagos	87(5.80)	910(30.33)	2783(107.04)	3780(53.24)
2	Ogun	2(0.13)	39(1.30)	185(7.12)	226(3.18)
3	Ekiti	1(0.07)	6(0.20)	12(0.46)	19(0.27)
4	Kwara	0(0.00)	12(0.40)	68(2.62)	80(1.13)
5	Oyo	8(0.53)	13(0.43)	227(8.73)	248(3.49)
6	Edo	2(0.13)	43(1.43)	172(6.62)	217(3.06)
7	Bauchi	2(0.13)	38(1.27)	196(7.54)	236(3.32)
8	Enugu	1(0.07)	0(0.00)	15(0.58)	16(0.23)
9	Osun	2(0.13)	29(0.97)	10(0.38)	41(0.58)
10	Rivers	1(0.07)	12(0.40)	144(5.54)	157(2.21)
11	Benue	1(0.07)	0(0.00)	4(0.15)	5(0.07)
12	Kaduna	3(0.20)	32(1.07)	175(6.73)	210(2.96)
13	Akwa Ibom	0(0.00)	16(0.53)	9(0.35)	25(0.35)
14	Ondo	0(0.00)	7(0.23)	15(0.58)	22(0.31)
15	Delta	0(0.00)	8(0.27)	40(1.54)	48(0.68)
16	Katsina	0(0.00)	40(1.33)	297(11.42)	337(4.75)
17	Niger	0(0.00)	2(0.07)	26(1.00)	28(0.39)
18	Anambra	0(0.00)	1(0.03)	9(0.35)	10(0.14)
19	Kano	0(0.00)	140(4.67)	704(27.08)	844(11.89)
20	Borno	0(0.00)	65(2.17)	190(7.31)	255(3.59)
21	Jigawa	0(0.00)	6(0.20)	234(9.00)	240(3.38)
22	Abia	0(0.00)	1(0.03)	6(0.23)	7(0.10)
23	Gombe	0(0.00)	77(2.57)	74(2.85)	151(2.13)
24	Sokoto	0(0.00)	36(1.20)	80(3.08)	116(1.63)
25	Adamawa	0(0.00)	2(0.07)	24(0.92)	26(0.37)
26	Plateau	0(0.00)	1(0.03)	98(3.77)	99(1.39)
27	Zamfara	0(0.00)	4(0.13)	80(3.08)	84(1.18)
28	Imo	0(0.00)	1(0.03)	32(1.23)	33(0.46)
29	Taraba	0(0.00)	8(0.27)	10(0.38)	18(0.25)
30	Bayelsa	0(0.00)	5(0.17)	7(0.27)	12(0.17)
31	Ebonyi	0(0.00)	2(0.07)	34(1.31)	36(0.51)
32	Kebbi	0(0.00)	2(0.07)	30(1.15)	32(0.45)
33	Nasarawa	0(0.00)	3(0.10)	54(2.08)	57(0.80)
34	Yobe	0(0.00)	1(0.03)	46(1.77)	47(0.66)

Note: Averages daily cases of coronavirus are shown in parenthesis.

Table 3
Correlation matrix.

	cases	*rrpc*	*gppc*	*ppc*	*tspc*	*wpc*	*rpc*
cases	1						
rrpc	−0.1856	1					
gppc	−0.1636	0.7053	1				
ppc	−0.3531	0.6196	0.5327	1			
tspc	−0.0560	0.8142	0.7716	0.5162	1		
wpc	−0.1790	0.7323	0.5623	0.5231	0.5605	1	
rpc	0.3046	−0.8509	−0.7642	−0.6641	−0.7316	−0.8329	1

Note: cases - Number of reported Covid-19 cases; rrpc - Retail and recreation percent change; gppc - Grocery and pharmacy percent change; ppc - Parks percent change; tspc - Transit stations percent change; wpc - Workplaces percent change; and rpc - Residential percent change.

coronavirus spread. By implication, as people comply with the "stay-at-home" order, and limit their visits to essential places, thus reduce their chances of being infected by COVID-19. Correspondingly, this also tends to reduce human-to-human contact, which is the main transmission channel of COVID-19. Intuitively, a 1% increase in compliance to the stay-at-home order leads to a corresponding reduction by the magnitudes 0.026%, 0.019%, 0.035%, 0.020% and 0.020%. On the contrary, the impact of residential is positive and statistically relevant. This sounds plausible as people desert essential places of visits, they tend to increase their presence at home. In particular, the majority of infected persons usually have one or more of their family members or close relatives infected. This explains why residential remains a key predicting channel to contacting COVID-19 and such reasons can be advanced as why COVID increases during the lockdown.

Table 5 presents the results of the alternative estimator of Poisson regression. The significance and signs of all the lockdown indicators are in agreement with the results in Table 4. This further accentuates the proposition underlining the effectiveness of lockdown measures as a potential determinant of COVID-19 cases in Nigeria.

6. Conclusion and policy implications

This study examines the extent to which lockdown measures impact on COVID-19 confirmed cases in Nigeria. Using the negative binomial regression estimator on the daily situation data, the following results are established. First, retail and recreation, grocery and pharmacy, parks, transit stations, and workplaces are negative and statistically significant across the models. Second, the impact of residential is positive and statistically relevant, thus running contrary to other lockdown measures with negative theoretical *priors*. Lastly, the obtained results are robust to an alternative estimator of Poisson Regression.

The study has some relevant policy implications. First, since the importance of lockdown policy has been quantitatively confirmed to be effective in combating the spread of COVID-19 cases, focus should be placed on residential houses, which act as a spur to the virus. This can be effectively achieved through public enlightening programs and general awareness on the need to comply with lockdown measures. More importantly, the government should guarantee and ensure constant supply of electricity to the people, their staying at home is largely predicated on enjoying uninterrupted supply of electricity. This sounds plausible in the Nigerian context where the supply of electricity has been erratic most times. This has often remained one of the reasons why people seek pleasure outside of their homes. This mostly takes the form of visits to relaxation centres like parks, recreation centres, restaurants, etc. Second, if the government has to ease the lockdown, at all, it must be gradual with all the necessary precautions dully enforced. Notwithstanding, this must be supported by sanctions to the defaulters. Third, lack of necessary welfare-oriented supports from the government serves as a reason people often advanced for not making them "compliant agent(s)" during the lockdown periods. Going forward, future research can be conducted using the state-level unit of observations for analysis in order to arrive at a more robust policy

Table 4
Negative binomial regression results of lockdown and COVID-19 cases.

Variables	Dependent variables: Number of COVID-19 cases														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Cases(−1)	**0.016*****	**0.017*****	**0.011*****	**0.017*****	**0.019*****	**0.016*****	**0.016*****	**0.012*****	**0.015*****	**0.016*****	**0.011*****	**0.017*****	**0.012*****	**0.014*****	**0.011*****
	(0.002)	**(0.002)**	**(0.001)**	**(0.002)**	**(0.001)**	**(0.002)**	**(0.002)**	**(0.002)**	**(0.002)**	**(0.002)**	**(0.002)**	**(0.002)**	**(0.002)**	**(0.002)**	**(0.002)**
% Δ of Retail and recreation	**−0.026*****						**−0.043*****			0.001			**−0.019****		−0.008
	(0.003)						**(0.008)**			(0.006)			**(0.009)**		(0.012)
% Δ of Grocery and pharmacy		**−0.019*****					**0.018****				0.001		**0.015****		**0.021****
		(0.003)					**(0.007)**				(0.004)		**(0.007)**		**(0.009)**
% Δ of Parks			**−0.035*****					**−0.031*****			**−0.035*****		**−0.029*****		**−0.021*****
			(0.003)					**(0.005)**			**(0.005)**		**(0.006)**		**(0.007)**
% Δ of Transit stations				**−0.020*****				−0.004				**−0.013*****		0.006	0.004
				(0.003)				(0.004)				**(0.004)**		(0.005)	(0.007)
% Δ of Workplaces					**−0.020*****				**0.023*****			**−0.010*****		**0.022*****	**0.024*****
					(0.002)				**(0.006)**			**(0.004)**		**(0.006)**	**(0.007)**
% Δ of Residential						**0.051*****			**0.090*****	**0.053*****				**0.095*****	**0.091*****
						(0.006)			**(0.011)**	**(0.011)**				**(0.015)**	**(0.020)**
Constant	**−2.783*****	**−2.271*****	**−2.633*****	**−2.365*****	**−2.454*****	**−2.632*****	**−2.933*****	**−2.690*****	**−2.586*****	**−2.614*****	**−2.619*****	**−2.421*****	**−2.791*****	**−2.428*****	**−2.719*****
	(0.178)	**(0.127)**	**(0.135)**	**(0.160)**	**(0.094)**	**(0.149)**	**(0.199)**	**(0.171)**	**(0.148)**	**(0.179)**	**(0.158)**	**(0.160)**	**(0.196)**	(0.162)	**(0.222)**
Wald chi-square	172.76	169.78	246.97	154.21	253.98	206.82	176.24	198.89	224.73	194.17	208.08	163.01	192.86	213.50	22,067
Prob.(Wald test)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Log Pseudo	−1271.1	−1417.0	−1499.4	−1389.7	−2176.7	−1304.1	−1253.3	−1235.8	−1296.4	−1185.6	−1213.3	−1386.3	−1116.9	−1219.8	−1061.1
Likelihood Ratio(LR)	209.86	253.54	221.82	250.66	240.12	153.57	203.86	162.78	156.01	143.57	191.08	215.53	174.23	131.66	99.94
Prob.(LR test)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
States(s)	34	31	25	21	34	23	31	19	23	23	24	21	24	19	18
Observations	1313	1350	1218	1104	2010	1115	1233	940	1115	1015	1014	1104	957	987	842

Note: *** $p < 0.01$, ** $p < 0.05$; estimates in parentheses are standard errors. The estimated values in bold forms indicate that the coefficients are statistical significant.

Table 5
Poisson regression results of lockdown and COVID-19 cases.

Variables	Dependent variables: Number of COVID-19 cases														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Cases(−1)	**0.013*** **	**0.013*** **	**0.010*** **	**0.014*** **	**0.014*** **	**0.013*** **	**0.013*** **	**0.010*** **	**0.012*** **	**0.013*** **	**0.010*** **	**0.014*** **	**0.009*** **	**0.012*** **	**0.009*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
% Δ of Retail and recreation	**−0.014*** **						0.000			**0.011*** **			**0.032*** **		**0.042*** **
	(0.001)						(0.004)			**(0.002)**			**(0.005)**		**(0.005)**
% Δ of Grocery and pharmacy		**−0.015*** **					**−0.013*** **				**0.007*** **		**−0.016*** **		−0.000
		(0.001)					**(0.004)**				**(0.001)**		**(0.004)**		(0.004)
% Δ of Parks			**−0.040*** **					**−0.036*** **			**−0.043*** **		**−0.049*** **		**−0.040*** **
			(0.002)					**(0.002)**			**(0.003)**		**(0.003)**		**(0.003)**
% Δ of Transit stations				**−0.019*** **				0.002				**−0.015*** **		**0.007*** **	**−0.010*** **
				(0.001)				(0.002)				**(0.002)**		**(0.002)**	**(0.003)**
% Δ of Workplaces					**−0.015*** **				**0.018*** **			**−0.006*** **		**0.019*** **	**0.021*** **
					(0.001)				**(0.002)**			**(0.001)**		**(0.002)**	**(0.003)**
% Δ of Residential						**0.035*** **			**0.068*** **	**0.051*** **				**0.079*** **	**0.084*** **
						(0.002)			**(0.005)**	**(0.004)**				**(0.007)**	**(0.008)**
Constant	−0.372	−0.129	**−0.504** **	0.090	0.130	−0.157	−0.138	−0.308	−0.201	−0.058	**−0.678** **	0.088	−0.368	0.034	−0.261
	(0.319)	(0.308)	**(0.254)**	(0.334)	(0.217)	(0.290)	(0.327)	(0.289)	(0.284)	(0.297)	**(0.280)**	(0.328)	(0.311)	(0.294)	(0.294)
Wald chi-square	1614.7	1690.9	1762.9	1667.3	1892.3	1710.1	1617.4	1611.9	1724.1	1735.3	1589.9	1679.9	1545.4	1735.8	1626.9
Prob.(Wald test)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Log Pseudo	−3036.6	−3271.2	−3482.2	−3334.3	−5386.7	−3058.8	−3009.6	−2930.6	−3027.1	−2809.6	−2797.7	−3323.4	−2607.0	−2892.3	−2454.1
Likelihood Ratio(LR)	4645.7	5076.2	3611.1	5786.2	5343.1	3083.8	4580.0	2705.7	3043.4	2923.6	2963.5	4535.9	2981.9	2597.8	1957.9
Prob.(LR test)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
State(s)	34	31	25	21	34	23	31	19	23	23	24	21	24	19	18
Observations	1313	1350	1218	1104	2010	1115	1233	940	1115	1015	1014	1104	957	987	842

Note: *** $p < 0.01$, ** $p < 0.05$; estimates in parentheses are standard errors. The estimated values in bold forms indicate that the coefficients are statistical significant.

generalization. What is more, since Nigeria shares similar socioeconomic and political characteristics with other African countries, the outcome of this research work could serve as useful research inputs for other countries in the region to extrapolate.

CRediT authorship contribution statement

All the authors participated in the making of the manuscript. Specifically, Kazeem Bello Ajide conceived and designed the manuscript. Ridwan Lanre Ibrahim provided empirical studies, data, and proofread the manuscript. Olorunfemi Yasiru Alimi handled the model estimation and proofread the manuscript.

Declaration of competing interest

The authors have no conflict of interest and no fund was received in favor of this study.

Appendix I. Definition of variables

Signs	Variables	Measurement	Sources
Cases	Cases	Number of reported COVID-19 cases	Nigeria Centre for Disease Control (NCDC, 2020
Rrpc	% Δ of retail and recreation	Retail and recreation percent change from baseline	NCDC (2020)
gppc	% Δ of grocery and pharmacy	Grocery and pharmacy percent change from baseline	NCDC (2020)
Ppc	% Δ of Parks	Parks percent change from baseline	NCDC (2020)
Tspc	% Δ of transit stations	Transit stations percent change from baseline	NCDC (2020)
Wpc	% Δ of workplaces	Workplaces percent change from baseline	NCDC (2020)
Rpc	% Δ of residential	Residential percent change from baseline	NCDC (2020)

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